

REMARKS

The Applicants thank the Examiner for the thorough consideration given the present application. Claims 18, 20, 23, and 35-38 were previously cancelled. Claim 12 is amended. Claims 1-7, 19, 21, 22, and 24-35 are pending, none of which is amended. Claim 1 is independent. The Examiner is respectfully requested to reconsider the rejections in view of the remarks set forth herein.

Request for Reconsideration / Reasons for Entry of Amendments

At the outset, it is respectfully submitted that the rejection of at least independent claim 1 is not proper and should be withdrawn. See arguments below.

By way of this Reply, claim 12 has been amended to correct an informality.

Accordingly, the pending claims of this Reply include only subject matter that has previously been considered and examined by the Examiner. The claims have not been amended. Thus, no issues are raised in the present Request for Reconsideration that would warrant an additional search of the related art on the part of the Examiner.

In the alternative, if the Examiner does not agree that this application is in condition for allowance, it is respectfully requested that this Reply be entered for the purpose of appeal. The arguments in this Reply were not presented at an earlier date in view of the fact it is believed that the Reply submitted on August 8, 2007 placed the application in condition for allowance. It is respectfully requested that the Examiner reconsider his rejections made in this Final Office Action.

Examiner Interview

If, during further examination of the present application, a discussion with the Applicants' Representative would advance the prosecution of the present application, the Examiner is encouraged to contact Carl T. Thomsen, Registration No. 50,786, at 1-703-208-4030 (direct line) at his convenience.

Restriction Requirement

The Applicants have previously cancelled non-elected claims 37 and 38. The Applicants reserve the right to file a divisional application directed to claims 37 and 38 at a later date if so desired.

Rejections Under 35 U.S.C. §103(a)

Claims 1-4, 11-14, 16, 17, 19, 21, 24-26, 28-31, 33, and 34 stand rejected under 35 U.S.C. §103(a) as being unpatentable over GB 2161647 in view of Buchanan et al. (U.S. 4,283,228) and further in view of Fernández et al.;

claims 5-10 and 15 stand rejected under 35 U.S.C. §103(a) as being unpatentable over GB 2161647 in view of Buchanan and further in view of Fernández et al. and either of Akiyama et al. or Thiele et al.;

claim 22 stands rejected under 35 U.S.C. §103(a) as being unpatentable over GB 2161647 in view of Buchanan et al., and further in view of Fernandez et al. and Maas et al.;

claim 27 stands rejected under 35 U.S.C. §103(a) as being unpatentable over GB 2161647 in view of Buchanan et al., and further in view of Fernandez et al. and Yao et al.; and

claim 32 stands rejected under 35 U.S.C. §103(a) as being unpatentable over GB 2161647 in view of Buchanan et al., and further in view of Fernandez et al. and Chen et al.

These rejections are respectfully traversed.

Arguments Regarding Independent Claim 1 as Previously Presented

Independent claim 1 as previously presented recites a combination of steps directed to a method of producing a piezoelectric ceramic thick film on a substrate, said method comprising:

- providing a piezoelectric ceramic material in powder form;
- forming a liquid mixture by mixing the powdered material with a liquid phase precursor of a metal oxide having a melting point lower than a temperature required for densifying the piezoelectric ceramic thick film by sintering, said precursor being adapted to decompose, upon subsequent annealing, into the metal oxide;

- drying the liquid mixture to form a precipitate;
- milling the precipitate to form a powdered precipitate;
- adding an organic carrier to the powdered precipitate;
- further milling the precipitate to form a paste;
- depositing a layer of the paste, as a wet film, onto the substrate; and

- annealing the layered substrate at a temperature and for a time sufficient to cause transformation of the paste into the thick film.

The Applicants respectfully submit that the combination of method steps as set forth in independent claim 1 is not disclosed or made obvious by the prior art of record, including GB 2161647 in view of Buchanan (U.S. 5,318,725) and further in view of Fernandez et al.

In GB2161647A, a powder of glass-like binding agent was added to the piezoelectric ceramic powder (Pg 1, Line 98; Pg 2, Line 48). However, the homogeneity achieved through mechanically mixing the powder of the binding agent with piezoelectric ceramic powder is limited, particularly when the amount of the binding agent is small.

Buchanan et al. (U.S. 4,283,228) merely discloses bulk ceramic processing, which is different from the thick film processing in the present invention. Furthermore, in the description of U.S. 4,283,228, in all the embodiments only the process of using V2O5 solid oxide suspended in a solvent or liquid (as a dispersant), but is not dissolved. In particular, refer to the second embodiment in which V2O5 is merely used as a sintering aid for the PZT powder. This is dispersed as a solid particle, which is different from the real liquid phase precursor as in independent claim 1. Although U.S. 4,283,228 mentions ammonium vanadate or vanadyl salts in general terms in Lines 6-11 in Column 2, these chemicals are simply used as a reactant with PZT as in the first embodiment, and U.S. 4,283,228 does not show how to take use their liquid phase to realize a uniform mixing of V2O5 with PZT powder when the V2O5 are used as a sintering aid as in the second embodiment.

The ceramic powder used to prepare the paste for thick film printing in the present invention is also different from that of U.S. 4,283,228 for bulk ceramic.

In the present invention, the ceramic powder comprises the “precipitated” piezoelectric ceramic particles from the suspension and the metal organics at the surfaces of the ceramic particles as the sintering aids. Such precipitated ceramic particles tend to aggregate seriously. Although the piezoelectric ceramic particles and the metal organics as the sintering aids have been uniformly mixed through the liquid phase approach, “milling the precipitate to form a powdered precipitate” is essential, followed by “further milling the precipitate to form a paste”. Only the present invention discloses that the metal organics as the sintering aids maintain their homogeneous distribution after the two mechanical millings, and that a quality thick film can still be obtained through the printing and annealing the ceramic paste. None of the cited references teaches or suggests this. Until the disclosure of the present invention, there was no known method of preventing the out-separation of the metal organics of the sintering aid from the ceramic powder due to their different specific weights during milling or due to possible dissolution of the metal organics in the organic carrier for printable thick film paste.

At least for the reasons explained above, the Applicants respectfully submit that the combination of method steps as set forth in independent claim 1 is not disclosed or made obvious by the prior art of record, including GB 2161647 in view of Buchanan et al. (U.S. 4,283,228) and further in view of Fernandez et al.

Therefore, independent claim 1 is in condition for allowance.

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Dependent Claims

All dependent claims are in condition for allowance due to their dependency from allowable independent claims, or due to the additional novel features set forth therein.

Accordingly, reconsideration and withdrawal of the rejections under 35 U.S.C. §103(a) are respectfully requested.

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CONCLUSION

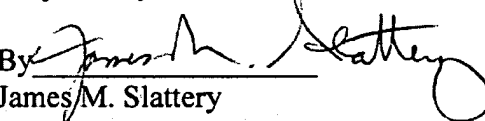
All of the stated grounds of rejection have been properly traversed, accommodated, or rendered moot. It is believed that a full and complete response has been made to the outstanding Office Action, and that the present application is in condition for allowance.

If the Examiner believes, for any reason, that personal communication will expedite prosecution of this application, he is invited to telephone Carl T. Thomsen (Reg. No. 50,786) at (703) 208-4030(direct line).

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. §§1.16 or 1.17, particularly extension of time fees.

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Respectfully submitted,

By 
James M. Slattery

Registration No.: 28,380

BIRCH, STEWART, KOLASCH & BIRCH, LLP

8110 Gatehouse Road

Suite 100 East

P.O. Box 747

Falls Church, Virginia 22040-0747

(703) 205-8000

Attorney for Applicant

Attachment: Notice of Appeal

JMS/CTT/mrh

